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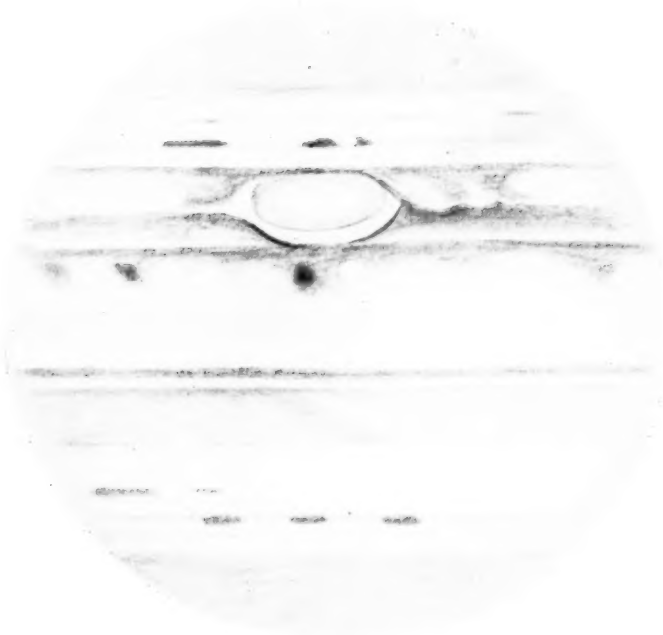
PLATE XXIV.



JUPITER

Drawn by W. F. Denning

July 7, 1902, 13h 54m.

THE JOURNAL
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VOL. IX. SEPTEMBER, 1915. No. 7

THE ROTATION PERIOD OF THE HOLLOW IN THE SOUTHERN EQUATORIAL BELT AND OF THE GREAT RED SPOT ON JUPITER

BY W. F. DENNING

EITHER the hollow in the southern belt, or great red spot, has been visible on Jupiter since September, 1831, when Heinrich Schwabe, at Dessau, saw the hollow and often delineated it in his drawings of the planet in that and succeeding years.

In the *Monthly Notices* of the R.A.S., Vol. LVIII., p. 488-93 and Vol. LIX., 574-84, I wrote papers on the "Early History of the Great Red Spot on Jupiter," and gave its rotation periods for the years 1831 to 1899.

It has lately become very desirable to extend the enquiry owing to some remarkable fluctuations in the motion of the spot and to the fact that during recent years (since 1901 and especially in and since 1910) the rate of the spot's motion has been greatly accelerated. In 1901 the rate of motion was $9^h\ 55^m\ 41^s{\cdot}6$, in 1914 it had decreased 8 seconds to $9^h\ 55^m\ 33^s{\cdot}6$.

The visible behavior of this marking has been greatly affected by a mass of dark material situated on the planet's south tropical bright zone and first seen in 1901.

M. Eugene Antoniadi was the first to point the effect out. The tropical spot or disturbance moves with greater celerity than the red-spot (its rotation period being about $9^h\ 55^m\ 20^s$) and is situated in similar latitude. As its swifter motion enables it to overtake the red-spot, the latter displays an increased speed and this is continued until the tropical disturbance has passed to the westward.

Between June, 1910, and June, 1914, (4 years) the great red-spot had so much increased its average velocity of previous years that it had lost 153° of longitude and this corresponds with a displacement of about 120,000 miles to the westward.

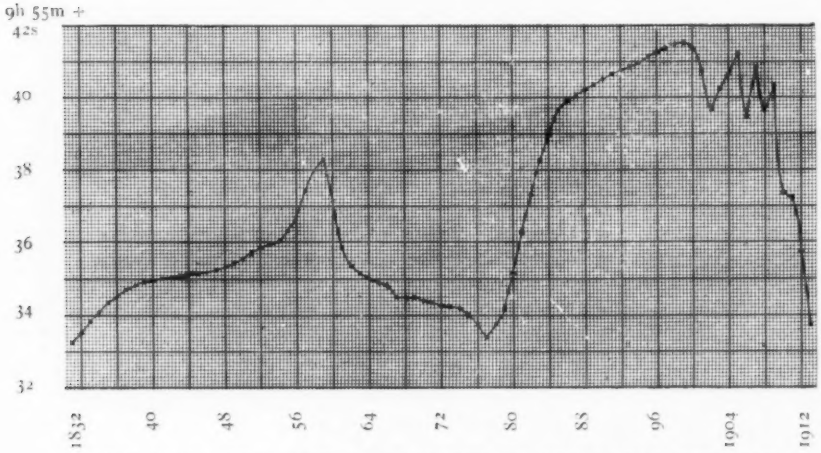
I give the annual rates of rotation of the red spot since 1831 ; they are the smoothed values up to 1900 after which the oscillations became so marked that it seems desirable to give the yearly value as they were individually determined.

Either the hollow or the red spot was well seen and drawn by some well-known observers in the early stages of its history including :—

H. Schwabe	1831	A. M. Mayer	1870
Rev. W. R. Dawes	1857	H. Pratt	1872
Sir W. Huggins	1858	J. Browning	1872
Capt. W. Noble	1860	E. B. Knobel	1872
J. Baxendell	1860	J. Birmingham	1872
J. W. Long	1860	Lord Rosse and Dr. R. Copeland	1872
Capt. W. S. Jacob	1860		
N. E. Green	1863	H. C. Russell	1876
T. W. Backhouse	1864	T. Bredechin	1876
J. Gledhill	1869	C. W. Pritchett	1878

PERIOD OF ROTATION

Year	h	m	s	Year	h	m	s	Year	h	m	s	Year	h	m	s
1831	9	55	33·3	1852	9	55	35·8	1873	9	55	34·3	1894	9	55	41·9
1832			33·6	1853			35·9	1874			34·2	1895			41·1
1833			33·9	1854			36·0	1875			34·0	1896			41·3
1834			34·1	1855			36·2	1876			33·7	1897			41·5
1835			34·3	1856			36·7	1877			33·4	1898			41·7
1836			34·5	1857			37·5	1878			33·7	1899			41·6
1837			34·7	1858			38·0	1879			34·1	1900			41·4
1838			34·8	1859			38·3	1880			35·2	1901			40·7
1839			34·9	1860			37·1	1881			36·3	1902			39·6
1840			35·0	1861			35·9	1882			37·3	1903			40·2
1841			35·0	1862			35·3	1883			35·2	1904			39·7
1842			35·1	1863			35·0	1884			39·0	1905			41·2
1843			35·1	1864			34·8	1885			39·6	1906			39·5
1844			35·2	1865			34·7	1886			39·9	1907			40·9
1845			35·2	1866			34·6	1887			40·1	1908			39·6
1846			35·3	1867			34·5	1888			40·2	1909			40·3
1847			35·3	1868			34·5	1889			40·4	1910			37·4
1848			35·4	1869			34·5	1890			40·5	1911			37·4
1849			35·5	1870			34·4	1891			40·6	1912			37·2
1850			35·6	1871			34·4	1892			40·8	1913			35·7
1851			35·7	1872			34·3	1893			40·9	1914			33·6



VARIATION IN THE RATE OF ROTATION OF THE GREAT RED SPOT ON JUPITER, 1831 TO 1914

The place for 1904 is given erroneously at 40½ instead of 39½.

I append a diagram exhibiting the changes and I think it may enable those interested to realize their extent far better than any verbal description can possibly do. On the left of the diagram I give the differences in period from $9^h\ 55^m\ 32^s$ to $9^h\ 55^m\ 42^s$ and on the lower edge are the years of observation.

I also give a sketch of Jupiter, 1902, July 7, $13^h\ 54^m$, showing the red-spot and the dusky south tropical disturbance both east and west of it. Plate XXIV. The disturbance sometimes appeared as a series of waves and it was usually preceded and followed by a brilliant spot.

During the 84 years, 1831–1914, the mean rotation period of the hollow and red-spot was :—

$$9^h\ 55^m\ 36^s{\cdot}9$$

from about 74,170 rotations.

Jupiter is now coming into a favorable situation for observation and it is to be hoped that the markings on his disc will be studied with increased attention during the remainder of the year.

It will be very interesting to determine the position of the red spot in longitude and to watch the future vagaries of the marking and of the south tropical disturbance. The motion of the red spot was as nearly as possible identical in rate in 1914 as in 1878. Will its speed continue to accelerate until its rotation period is less in value than has ever before been observed? The marking is placed in a current of obviously greater velocity as indicated by the south tropical disturbance. The latter object and the red spot came to conjunction at intervals of about two years in 1902–8, but the differences in their relative motions which have taken place have increased the intervals to about three years.

It is quite possible that the modern red spot is really indentical with Hooke and Cassini's great spot, discovered in May, 1664. Cassini observed it very successfully in 1665 to 1667 and again in 1672. I gave some details in *Monthly Notices*, LIX., p. 580 2.

LATER ADDITION

A good observation of this feature was obtained by Mr. F. Sargent, F.R.A.S., of Bristol, on July 1, 1915, $14^h\ 47^m$, when its longitude was 172°. This proves that a decided slackening of velocity has occurred in the motion of the object since June, 1914, when the longitude was 207°. The rotation period has, therefore, increased from $9^h\ 55^m\ 33^s{\cdot}6$ January to June, 1914, to $9^h\ 55^m\ 36^s{\cdot}6$ July, 1914, to July, 1915. This is quite in accordance with previous experiences, for it has been found that when the south tropical disturbance passes to the west of the red spot and hollow, the latter formations immediately exhibit a slower rate of velocity.

BRISTOL, ENGLAND,
July 26, 1915.

THE ORBIT OF *B. A. C.* 5890

By T. H. Parker

THIS star ($\alpha = 17^h\ 21^m{\cdot}3$, $\delta = -5°$) was confirmed as a spectroscopic binary by Mr. Burns from the measures of a plate obtained at the Lick Observatory on June 21, 1905. This plate showed a doubling of the lines with a ratio of intensity of about two to one. Two plates had been previously obtained in 1899 and 1900 which had only single lines. In *Astrophysical Journal*, Vol. XXV., a list of measures of eight plates is given. Of this series three give the velocities of both components with a range of 151 km. The star is an *F* type with fairly broad lines and is of photographic magnitude 4·9. The following orbit was determined from the measures of nineteen plates taken at Ottawa showing both spectra, together with the three Lick observations already mentioned. A large number of plates of this star were obtained here which were later found to be unsuitable in the determination of the orbit on account of the blending of the two spectra. The latter were only found separated near the primary maximum. Fortunately, however, one of the Lick observations showed double lines at a phase near Apastron due to the larger dispersion of the Mills spectragh. The velocities given by this plate were of great use in finding the values of K' in the case of each component as will be noted later. In all thirty-one lines were measured on the various plates of which about a dozen occurred but few times. A selection was made of eleven of the best lines remaining for which the wave-lengths were corrected af follows :—

TABLE I.

Wave-Length	Element
4549·753	Iron
4481·548	Magnesium
4352·035	Chromium-Magnesium
4340·646	Hydrogen
4271·689	Iron
4260·654	Iron
4233·483	Magnesium-Iron
4226·968	Iron
4143·832	Iron
4101·890	Hydrogen
4045·935	Iron

A summary of the observations used is given in the following tables. In Table II. will be found the Lick observations, giving the velocities as kindly communicated from the Director by Dr. Moore, the Julian Day for each plate having been sent previously. It will be noted that the values of the velocities in this table as recently received, are slightly different from those already published, and which were used in the following solutions. These changes are due to a small correction determined from a discussion of the residual given by the line λ 4500 on all spectrograms of *F* type stars. In each case the residuals of these corrected values of the observed velocities from the final curve are less than those given by the former measures. Table III. contains the Ottawa observations and, as in Table II., in each case the phase is reckoned from periastron and the residual from the final curve.

TABLE II.—LICK OBSERVATIONS

Plate	Date	Julian Day	Phase	Component I.		Component II.	
				Velocity	O. C.	Velocity	O. C.
	1905						
5851B.	June 21	2,417,018·828	26·104	*+ 69·0		*- 82·0	
				+ 69·6	- 0·6	- 80·1	- 6·1
	1906						
4324B.	July 22	7,414·795	1·690	*+ 29·0		*- 31·0	
				+ 28·8	- 1·6	- 31·2	+ 0·5
4348A.	August 1	7,424·714	11·600	- 23·8	+ 0·4	+ 30·0	+ 3·3
				*- 25·0			

* Values published in Lick Observatory *Bulletin*, Vol. IV., 96.

TABLE III.

OTTAWA OBSERVATIONS

Plate	Obs.	Date	Exp.	Julian Day	Phase	Component I.			Component II.		
						Vel.	Wt.	O-C	Vel.	Wt.	O-C
		1910	m								
3477	P	June 9	58	2,418,832·796	0·875	+44·8	3	− 5·0	−57·2	½	− 4·8
3506	H-C	July 4	93	857·695	25·774	+68·6	7	− 1·6	−71·7	5	+ 2·6
3587	P	Aug. 26	65	910·605	26·135	+65·0	5	− 5·4	−76·9	3	− 3·6
		1911									
4219	C	Apr. 19	65	9,146·873	25·936	+74·8	6	+ 4·1	−58·1	4	+16·3
4226	H	Apr. 20	67	147·856	0·644	+61·9	5	+ 4·0	−56·9	2	+ 3·9
4307	P	May 16	74	173·849	0·363	+66·1	3	+ 3·4	−81·8	2	− 4·0
4416	P	July 6	65	224·633	24·873	+62·6	6	+ 4·0	−50·7	3	+10·7
4421	C	July 7	80	225·660	25·900	+80·3	5	+ 9·9	−58·9	2	+15·5
4466	H	Aug. 1	85	250·575	24·541	+46·8	3	− 4·5	−63·6	2	− 9·2
4502	H	Aug. 29	74	278·574	26·266	+65·0	6	− 3·7	−71·8	4	+ 1·1
4586	C	Sept. 22	68	302·522	23·939	+25·7	4	−14·8	−61·9	1	−19·8
4595	H	Sept. 26	75	306·515	1·058	+43·4	5	+12·8	−27·6	2	+ 5·7
4656	C	Oct. 19	70	329·509	24·643	+52·7	1	− 3·9	−71·8	½	−15·5
		1912									
4921	P	Mch. 25	83	487·902	25·400	+73·0	4	+ 5·7	−64·4	2	+ 8·5
4975	P	Apr. 20	72	513·833	25·057	+52·9	3	− 7·5	−82·6	2	−19·0
5045	P	June 12	100	566·773	25·448	+73·0	4	+ 3·6	−66·9	1	+ 3·3
5051	C-H	June 13	90	567·742	0·143	+64·6	5	0·0	−65·1	3	+ 4·0
5172	C	Aug. 29	90	644·557	24·410	+51·8	5	+ 2·0	−46·6	2	+ 5·7
		1913									
5589	C-P	June 16	70	935·743	0·305	+81·6	1	+16·3	−80·7	1	−11·9

The nineteen Ottawa observations were grouped into five normal places and those from Lick were taken separately to form three additional places. In the latter case equal weights were assigned and each place was given approximately three times the weight of an average single Ottawa observation. The normal places for both components are given in Table IV., together with the mean phase from periastron, mean velocity, weight and residual from computed velocities of the preliminary elements.

TABLE IV.

NORMAL PLACES I.

No.	Mean Phase	Mean Velocity	Weight	O—C
1	25·026	+ 42·1	1·5	+ 0·8
2	25·645	+ 58·9	1·0	− 2·2
3	0·194	+ 74·9	3·0	− 1·0
4	0·567	+ 69·0	1·5	− 2·7
5	0·834	+ 63·3	2·0	− 2·9
6	1·829	+ 48·5	1·5	+ 6·5
7	2·421	+ 29·0	1·5	− 0·5
8	12·340	− 25·0	1·5	− 1·4
9	25·108	56·0	·5	− 10·5
10	25·660	− 64·5	·5	− 2·4
11	0·227	− 64·2	1·5	+ 10·7
12	0·567	− 82·0	1·0	− 10·2
13	0·818	73·6	1·5	− 6·5
14	1·860	− 45·5	·5	− 2·4
15	2·421	− 31·0	1·	+ 0·9
16	12·340	+ 30·0	1·	+ 11·8

Using the graphical method these preliminary elements were obtained :—

$$P = 26{\cdot}2742 \text{ days}$$
$$e = {\cdot}55$$
$$\omega_1 = 350°$$
$$\omega_2 = 170°$$
$$K_1 = 50 \text{ km.}$$
$$K_2 = 47{\cdot}3 \text{ km.}$$
$$\gamma = -2{\cdot}08 \text{ km.}$$
$$T = 2{,}418{,}410{\cdot}794 \text{ J. D.}$$

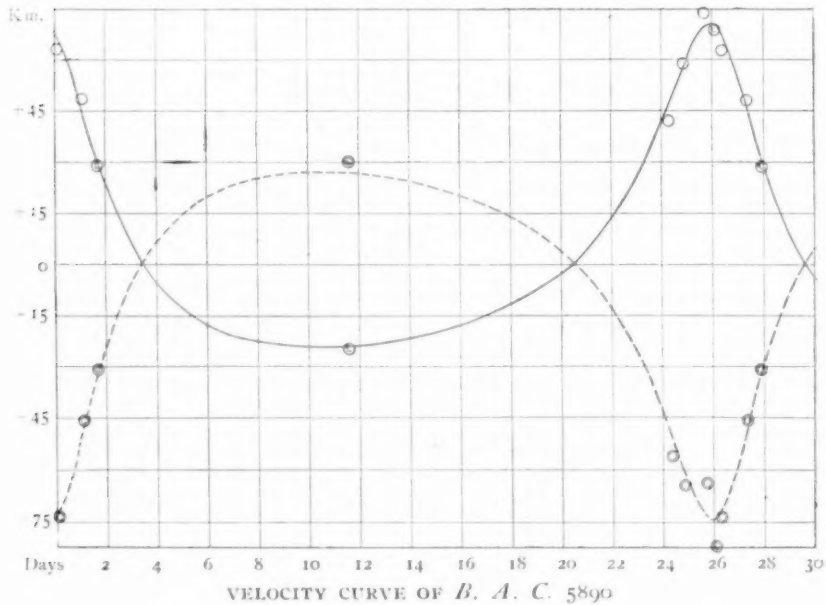
As previously noted, one of the Lick observations was a great help in fixing the values of K_1 and K_2 above. This plate (4348*A*) is the third in Table II. with velocities of − 25·0 km. and + 30 km. for the first and second components respectively. It is the only plate giving any idea of the minimum of the primary or the maximum of the secondary. The note accompanying the measure speaks of the secondary as the strong, and the primary as the weak component. This is just opposite to what has been found in all other plates. Although, as will be seen later, the masses of the two bodies are not very different, and conse-

quently the secondary may show stronger than the primary in some cases.

It was found necessary to carry through three least-squares solutions before satisfactory results were obtained. The effects of these will be seen in the summary below. (Table V.).

TABLE V.

Element	Preliminary	I	II	III	Prob. Error
P	26·2742 days	26·2742	26·2742	26·2742 days	
e	·55	·489	·4875	·4912	± ·011
ω_1	350°	4°·71	15°·10	14°·48	± 7°·55
ω_2	170°	184°·71	195°·10	194°·48	
K_1	50 km.	46·5 km.	47·36 km.	47·49 km.	± 1·03km.
K_2	47·3 km.	48·99 km.	50·35 km.	50·67 km.	± 1·18km.
γ	− 2·08 km.	+ ·09 km.	+ ·38 km.	+ ·44 km.	± 1·03km.
T	2,418,410·794 J.D.	8,411·198 I.D.	8,411·555 J.D.	2,418,411·524 J.D.	± ·30 days
$a \sin i$	. . . . .	. . . . .	. . . . .	14,950,000 km.	



VELOCITY CURVE OF *B. A. C.* 5890

The probable error of a single observation of average weight was found to be ± 5·6 for the primary component and ± 6·6 for the secondary.

The probable error of a normal place for the primary is ± 4·0 and for the secondary component ± 5·2.

In the published note in *L. O. B.*, Vol. IV., it was stated that it seems probable that the masses of the stars are not very different, and from the elements determined above this would appear to be the case.

The relation between the masses of the two stars is given by $M_1 : M_2 = K_2 : K_1 = 25 : 24$.

In the accompanying figure the single circles indicate the observations of the primary and the double circles those of the secondary component. The Lick observations are shown by an *L* within the circle.

DOMINION OBSERVATORY,
OTTAWA, CANADA,
June 14, 1915

THE INFLUENCE OF ASTRONOMY

By John W. Lethaby

WHEN we forget the laws we have learned, and imagine ourselves with Homer's people trying to account for the perpetually shifting pageant of the sky by the light of our own unaided senses, eked out by gleams of intuitive philosophy, we begin to be awed by the wonder of this Greek achievement.

To those who can rightly measure greatness of mind, the system of Ptolemy, built up by the successive labor of generations of Greek astronomers, before natural science was invented, is a more splendid witness to the power of the human intellect than anything we have to show to-day in dreadnoughts or telephones. What matters it that Ptolemy was wrong? In all essential things he was as right as Kepler, Herschel or Newton. He reduced the heavens to an ordered march. Bringing to a conclusion the work of the ancient astronomers, he unmasked the idea of the sky's infinity, and of man "upon an isthmus of a middle state."

The common people of old watched the sky with keen intentness. We have the month — from the moon. Sanscrit, ma-measure: Monday, Sunday. The ideas of our life are steeped in star lore. A man is unlucky, and we say he is "ill-starred." Napoleon followed his star, but it was a will-of-the-wisp and led him to the disaster at Waterloo. "The stars in their courses fought against Sisera." The sun is father, the moon mother and all the stars the children to Joseph and to the black men in the Congo hinterland to-day. A shadow told the time to Ahaz, and to-day a shadow bids the Kaffir plant his corn. The sun-dial, Time with his scythe, the hour glass, the setting and rising sun, all these are familiar on our lips day by day.

In a little churchyard near Clifton, that might have been

the scene of Gray's "Elegy," there is a yew that stood there when William came to Senlac. On the tower is a sun-dial, that has told the passing hour to men since Cromwell. The whole place is saturated in history and old-world charm. Edmund Burke came there one day, and looked up at the old dial; "Pulvis et umbra sumus" he read. . . "We are but dust and shadow." He went away thoughtful and in one of his finest passages of the "French Revolution" he re-coins that phrase in his own immortal way, "What dust we are and what shadows we pursue."

May I suggest as a very interesting topic for a paper by one of our members, "Old Dials and Methods of Measuring Time?"

On Dante the writer spent the leisure of a winter's evenings. Dante accepted the universe of Ptolemy for his "Divine Comedy," and was almost always correct in his celestial geography. It is marvellous to follow that splendid mind through the cycles and epicycles of Ptolemy. In this respect he vastly differed from Milton. When the Archangel tells Adam about the creation of the world, he has to confess that he does not know whether the sun goes round the earth, or the earth round the sun. The Great Architect, it seems, concealed this from men and from angels,

> "Perhaps to move
> His laughter at their quaint opinions wide."

It was a poor jest, if we must believe it, and mankind at the end, has had its laugh. Milton was hiding his ignorance of the heavenly vision, Dante needed no such excuse, and his undying poem will shine with brighter fame by reason of his knowledge of the stars.

My subject is vast, and only a corner of the field can be surveyed. Take our great poets. They are simply filled with astronomical influences.

Shakespeare gives over 300 as far as it has been possible to check up the figures. Keats probably wrote the most perfect lines with reference to students of the "Queen of Sciences."

You will find them in a sonnet, "On First Opening Chapman's Homer": —

> "Then felt I like some watcher of the skies,
> When a new planet swims into his ken."

And in this connection it might be well to point out that one can discover a planet without seeing it, and see a star without discovering. One of my coaches knew Adams well, and declared that Adams's discovery of Neptune by sheer calculation in his study, which discovery was made at the same time by Leverrier, was the greatest achievement of the human intellect.

Of all the epigrams attributed to Plato, the most famous has been expanded by Shelley into four glorious lines:—

> "Thou wert the morning star among the living,
> Ere thy pure light had fled;
> Now having died, thou art as Hesperus giving
> New splendor to the dead."

Here Venus is referred to, known to Homer, Virgil, Martial and Pliny as "Lucifer," the Son of the Morning. Records are found of Venus on the stone of Nineveh, B.C. 684. In the evening it was called Hesperus. If we were in Venus, looking at the earth and the moon, when in opposition, we should see the earth shine as a star about half as bright as Venus, the moon about equal to Sirius, the two forming a naked eye double star, perhaps the finest sight in the Universe.

Our language is full of reference to comets. A special vintage is called "a comet wine." Mr. Wells tells us in "The Days of the Comet" how a new atmosphere was created and man was transformed. Mr. Kipling declares that in the perfect age we shall paint with "brushes of comets' tails." On the Bayeux Tapestry we find a picture of Halley's Comet which appeared on March 25, 1066,— a red-letter year in our history. The Chinese records tally exactly with this: very creditable for astronomy in the Celestial Empire.

Take again meteors. "The image that fell from Jupiter" was undoubtedly one of these whirling stones. So we read

"great stones from heaven rained down" in Joshua's day. It is interesting to note that Peary found the largest known specimen, weighing 36½ tons, in Greenland. It now lies in the American Museum of Natural History. In the theatre of the Royal Institution in London, Professor Odling once lit up the room with gases brought from interstellar space — helium, hydrogen and carbon oxides contained in a meteor.

In the hands of our Secretary I shall place a list of over 200 books consulted by the writer during the last few years on this subject, and it is entirely at the service of his fellow students. Thomas Hardy in "Two on a Tower," Mark Rutherford in "The Revolution in Tanner's Lane," H. G. Wells, and Jules Verne have made astronomy the base of much fine fiction.

As a final picture of what literature has given to be the extent of our knowledge, let us suppose, with Mr. Wells, that we have been able to cut ourselves free from matter. No pull of gravity will act. We can indeed not leave the earth, but the earth will drop away from us. Up above the gleaming waters of the Strait, we can look down upon the roofs and spires of Victoria. The little earth whirls on its axis, and soon we lose the blue sky. Merging into the dark blue of midnight, we pass into the inky blackness of a frosty starlight. Then into utter blackness. The stars that we cannot see by day by reason of the irradiation of the sun, now we can see like an innumerable host. The sun was not yellowish as we see it, but a disc of blinding white, streaked with scarlet veins and shooting out, brighter than the Milky Way, two great pinions of silver white, the solar corona.

Still the little globe drops away, until all North America gleams like a silvery pear. We see the whole circle of the earth. As she shrinks, the broad moon in its third quarter creeps into view over the disc. Look for the constellations. Only Aries (behind the sun) and the Lion (covered by the earth) are hidden.

We see the tattered glory of the Milky Way, with Vega very bright: Sirius and Orion shine splendid against the black-

ness of the opposite quarter of the heavens. The Pole Star is right overhead, and the Great Bear hangs over the circle of the earth. Away beneath and beyond the corona of the sun, you shall see the four bright stars like a jewelled dagger, that form the Southern Cross. All larger than ever. Aldebaran is a blood-stone full of fire. Sirius condenses into one point the light of a world of sapphires. Far away Mars shines steadily, a pink pin's head.

Time between thought and thought grows greater. We watch the moon spinning round the earth, and can clearly see the motion of Mars in his orbit.

Still on we fly, amid a rain of cosmic dust. Hercules and the Scorpion get together: Orion and Aldebaran scatter, Saturn rushes down upon us, and as we gaze up we see the triple belt like three circles of moonlight, and seven of the satellites. Like a flash of lightning the planet is gone. Earth is out of sight. We come to the marches of the Outer Universe. We move faster and faster towards a point between Orion's belt and sword. All is black and blank. We have come into the wilderness of space.

And yet? . . . . . Our universe a faint glow in the distance, what remains? Professor Kapteyn states his view that there is yet a second universe like ours. Perhaps we should see the reddish dawn of a new system. Here we halt; science and literature are dumb.

So much for the influence of astronomy in the past. What of the future? With more patient observation, with finer instruments, with more accurate calculation, new light will yet break on the problems of the universe. Perchance our new telescope at Little Saanich Mountain, B.C., will reveal to the sensitive plate of the camera knowledge over which hangs a veil. Some day our little ignorance will vanish like the dew of morning, our little systems will have had their day; the curtain will roll up, and we shall gaze, marvelling yet unafraid, on the beauty and mystery of the skies.

VICTORIA, B.C.

ON THE DIURNAL CHANGES IN MAGNETIC DECLINATION AT AGINCOURT, 1902-1912

By W. E. W. Jackson

THE changes which take place in the direction of the earth's magnetic field at any one station must be thoroughly known before we can say definitely what direction a magnet, if suspended freely, will take with reference to a meridian. Before the establishment of fixed observatories it was known that there were certain times of the day when the needle would point in a different direction to other times, but as the angular values were small and of little moment for mariners' purposes, no thorough study was made of them. In the early part of the 19th century it was noted by different philosophers, amongst whom was von Humboldt, that the diurnal range was not always of the same amount, that it varied from place to place, and also with the season of the year.

At the request of the Royal Society and the British Association, due to von Humboldt's efforts, several observatories were authorized by the British Government to be established in different parts of the British possessions for the investigation of the changes taking place in the earth's magnetism, and one of these was established at Toronto in 1839, where it was kept in operation until 1897, when, on account of electric disturbance from the trolley system, it became necessary to move to the present quarters at Agincourt, some 12 miles distant.

Since 1880 photographic records of the changes in the earth's magnetic forces have been obtained; prior to that time the records were all from actual eye observations.

Herewith is a summary of results obtained from an analysis of the curves secured at Agincourt during the eleven-year period 1902 to 1912.

Measurements have been made from the curves at every hour of the 24, for all days, and these hourly values have been combined for each calendar month, and taking in succession the difference of each hourly value from the arithmetic mean for the month, we obtain what is known as the diurnal inequality. The smooth progression so obtained in the hourly means from a large number of days is seen in but very few if any of the individual days.

In Table I. is given the diurnal inequality of Declination at Agincourt for each month of the year derived from all days of the eleven years, 1902 to 1912. Distinct maxima and minima are in heavy type and the last line gives the ranges as derived from the hourly values. For instance in January the greatest positive value is 3·27, the greatest negative value is 2·58, and the sum of these is 5 85.

TABLE I.

DIURNAL INEQUALITY OF DECLINATION AT AGINCOURT

ALL DAYS, 1902-1912

Hour	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	−0·17	−0·52	−0·95	−1·00	0·71	−0·29	−0·74	−0·55	−0·52	−0·46	−0·12	−0·32
2	**+0·05**	−0·31	−0·82	**−0·78**	−0·71	**+0·01**	**+0·16**	**+0·33**	−0·35	**−0·26**	**+0·37**	+0·19
3	−0·25	**−0·26**	**−0·59**	−1·28	**−0·57**	−0·36	+0·07	−0·37	−1·18	−0·63	−0·00	**+0·19**
4	−0·31	−0·41	−0·83	**−1·12**	−0·94	−0·70	−0·41	−0·61	−1·95	−0·85	−0·47	−0·25
5	−0·36	−0·64	−1·00	**−1·69**	−2·33	−1·99	−1·74	**−1·72**	**−1·73**	−0·90	−0·91	−0·64
6	−0·48	−1·06	−1·23	−2·42	−3·88	−3·78	−3·71	−3·79	−2·92	−0·87	−1·34	−0·76
7	−0·63	−0·87	−2·29	−3·42	−4·59	−5·21	−5·32	−5·57	−4·52	−1·96	−1·37	−0·89
8	−1·42	−1·71	−3·60	**−4·26**	**−4·84**	**−5·49**	**−5·78**	**−6·20**	**−4·63**	−2·75	−2·02	−1·35
9	**−2·58**	**−2·59**	**−3·73**	−3·94	−3·69	−4·30	−4·82	−4·84	−3·17	**−3·02**	**−2·37**	**−1·97**
10	−2·31	−1·90	−2·61	−1·97	−1·11	−1·81	−2·21	−1·21	−0·33	−1·36	−1·12	−1·26
11	−0·11	−0·30	0·00	+1·05	**+2·31**	+1·47	+1·21	+2·88	+3·08	+0·95	+0·96	+0·46
Noon	+1·79	+1·78	+3·04	+3·98	**+4·77**	+4·25	+4·21	+5·90	+5·76	+3·49	+3·04	+2·33
13	+2·98	+3·07	+4·63	+5·49	**+5·60**	**+5·44**	+5·62	**+6·93**	**+6·22**	**+4·49**	**+3·79**	**+3·28**
14	**+3·27**	**+3·57**	**+5·03**	**+5·83**	+5·48	+5·36	**+5·72**	+6·56	+5·43	+4·20	+3·51	+3·09
15	+2·81	+3·12	+4·36	+4·87	+4·52	+4·60	+4·82	+4·71	+3·47	+3·26	+2·42	+2·31
16	+2·05	+2·38	+3·11	+3·52	+2·91	+3·23	+3·51	+2·81	+1·56	+1·99	+1·47	+1·02
17	+0·94	+1·33	+1·66	+1·90	+1·36	+1·61	+1·74	+1·09	+0·21	+0·96	+0·70	+0·71
18	+0·35	+0·45	+0·85	+0·42	+0·15	+0·53	+0·60	−0·10	−0·35	+0·48	+0·05	+0·11
19	−0·36	+0·05	+0·13	−0·25	−0·24	−0·02	−0·21	−0·70	−0·49	−0·45	0·72	−0·72
20	−0·82	−0·74	−0·47	−0·46	−0·42	−0·24	−0·20	−0·75	−0·66	−1·28	−1·13	−1·21
21	−1·23	**−1·49**	−1·14	−1·02	−0·72	−0·71	−0·45	−1·25	**−1·29**	**−1·70**	−1·50	**−1·72**
22	**−1·58**	−1·30	**−1·36**	**−1·40**	−0·66	−0·55	−0·68	**−1·40**	−0·94	−1·28	**−1·61**	−1·21
23	−1·01	−0·97	−1·14	−1·09	**−1·01**	**−0·78**	**−0·83**	−1·34	−0·48	−1·11	−1·09	−1·15
24	−0·66	−0·68	−1·05	−0·98	−0·70	−0·40	−0·67	−0·71	**−0·07**	−0·88	−0·64	−0·56
Range	5·85	6·07	8·76	10·09	10·44	10·93	11·51	13·13	10·85	7·51	6·16	5·25

The monthly diurnal curves are exhibited graphically in Figure 1, where the distinctive characteristics of the different seasons of the year can be readily seen. The extent to which the type of the curves vary with the season can better be grasped by taking the inequality for March and drawing it to scale, and then representing December and June on scales so related that the mean length of the 24 hour ordinates is the same as for

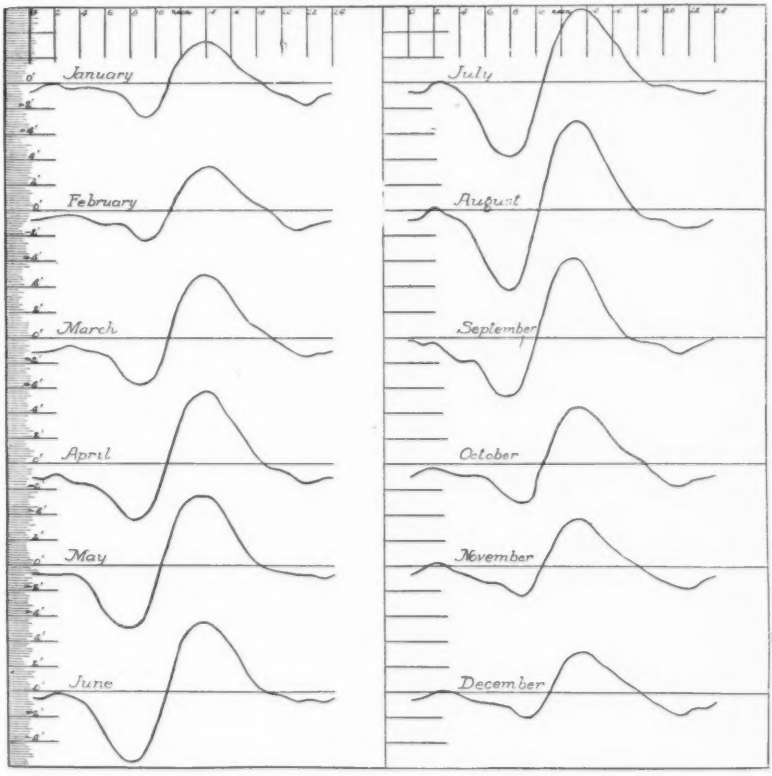


FIGURE 1.

MAGNETIC DECLINATION

As recorded at Agincourt, all days, 1902-1912.

March. This is shown in Figure 2. It will be seen that the difference in type is mainly confined to the hours between 6 p.m. and 9 a.m., when the differences from the mean are the least and the changes less rapid.

It has long been accepted by magneticians that some relationship exists between magnetism and sun spots, but the nature of that relationship has not yet been definitely established. The inequality range, so far as known, is above the mean in years of many sun spots, and the excess is conspicuous in years when sun spot frequency is greatest. Table II. contrasts the diurnal

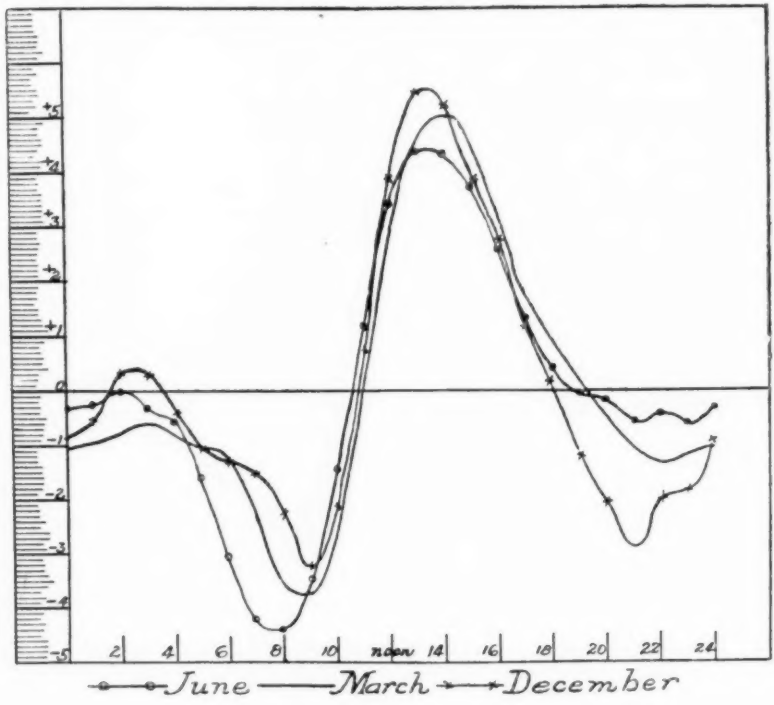


FIGURE 2.

MAGNETIC DECLINATION, SEASONAL TYPE.

inequality ranges at Agincourt during a period of eleven years from 1902 to 1912. and two years of maximum sun spots frequency 1905 and 1906, and two years of minimum sun spot frequency 1902 and 1912. The mean frequencies for these periods, as given by Professor Wolfer*, are 33·7, 58·6 and 4·3, respectively.

TABLE II.

DECLINATION RANGES AT AGINCOURT

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
All years	5·85	6·07	8·76	10·00	10·44	10·93	11·51	13·13	10·85	7·51	6·16	5·25
Max. spot years	6·82	6·32	9·82	10·98	10·95	10·54	11·54	13·15	10·96	7·44	6·76	5·09
Min. spot years	4·71	5·34	8·65	9·63	10·73	10·81	10·82	12·78	10·17	7·40	5·58	4·60

PERCENTAGE VALUES

All years	66	68	99	114	118	123	130	148	122	85	69	59
Max. spot years	74	69	107	119	119	115	126	143	119	81	73	55
Min. spot years	56	63	102	114	127	128	128	152	121	88	66	55

The ranges are also given, expressed in percentage values of their arithmetic mean, from which we can the better see the effect produced during the maximum sun spot period.

From the ranges themselves it is noticed that those in maximum spot years are throughout the year larger than in minimum spot years, but that the difference is more marked in winter than in summer, but if we now examine the percentage values we see that the effect of the maximum spot period is to bring the winter and summer values nearer together.

The time of occurrence of maximum is always later in years of maximum sun spots than in years of minimum sun spots, but it varies with the season, being greatest in winter.

The writer has made a detailed mathematical investigation into the various results of observations; for it, reference may be made to the *Transactions* of the Royal Society of Canada for 1914, page 105-112.

* *Bulletin* Mount Weather Observatory, Vol. V., Part 6.

METEOROLOGICAL OFFICE,
TORONTO

MEETINGS OF THE SOCIETY

At Toronto

May 4,—The regular meeting of the Society was held in the Society's Rooms, 198 College Street, this evening, Dr. C. A. Chant being in the chair.

The Corresponding Secretary exhibited lantern slides made from prints of spectra of Venus and Jupiter received from the Lowell Observatory.

The paper for the evening was given by Dr. R. E. DeLury, of the Dominion Observatory, Ottawa, on "Recent Investigations of the Sun's Spectrum." Dr. DeLury explained how investigators at present are studying the condition of the sun by comparing its spectra with those obtained in the laboratory when alterations are made in the temperature, pressure, magnetic field, etc. By means of lantern slides he showed the equipment at Ottawa for the study of the sun and gave a somewhat detailed account of the work done there.

The thanks of those present were conveyed to Dr. DeLury for his interesting and instructive address.

The Corresponding Secretary was instructed to communicate with the Ottawa Centre to see that the Society was represented at the meeting of the Royal Society of Canada.

May 18,—The regular meeting of the Society was held this evening in the Society's Rooms.

Ellison Hawkes, Leeds, England, was elected a member of the Society.

Mr. Luno, of Swansea, invited the members to visit him and use his telescope.

Mr. J. R. Collins addressed the meeting on the "Summer Constellations," which he illustrated by means of charts and lantern slides. Reference was made to the prominent stars and the means of identifying them.

Following Mr. Collins, Dr. D. B. Marsh gave an interesting talk on photography with the aid of small telescopes, his remarks being based chiefly on his own experiences. The talk was illustrated by means of lantern slides showing some recent photographs of sun-spots and of the moon, by means of a three-inch and a five-inch telescope.

June 1,— An Open Air Meeting for observation with telescopes was held on the University Campus, this evening.

The early part of the evening was cloudy, but, as the night advanced the sky became clear and the seeing was fairly good. A number of interesting objects were observed, including the planet Mercury, which was very well seen in the early part of the evening. The instruments supplied were, the Society's 4-inch Cooke Telescope, a 4 and a 3-inch from the Department of Astronomy of the University, kindly furnished by Professor Chant, and a 3-inch by Dr. Marsh, of Holstein, Ontario.

W. E. W. Jackson, *Rec.-Sec.*

At Hamilton

April 23,—Dr. D. B. Marsh delivered a very interesting lecture entitled "Examining the Solar Surface."

The lecture was illustrated by a number of lantern slides and was much enjoyed by all.

May 14,—Mr. R. F. Stupart, of Toronto, Director of the Meteorological Service, lectured this evening on the "Atmosphere."

The changes in barometrical measurements at different places

and at different times were pointed out and the cause of these, *viz.*, differences in temperature, explained.

Investigations as to the variation of temperature with height above the surface of the earth had led to the discovery of the "isothermal layer," which had been explored from about seven miles to twenty miles above the earth's surface, the temperature found varying from 75 to 115 degrees below zero. These investigations had led some physicists to doubt if the temperature of space did ever reach the absolute zero.

A number of maps explanatory of the origin and course of storms were shown, one set being of especial interest as it showed the course of the great storm of November, 1913.

At the close the lecturer answered a number of questions and was then tendered a hearty vote of thanks.

T. H. WINGHAM, *Sec.*

NOTES FROM THE METEOROLOGICAL SERVICE

Summary Report of the Weather in Canada

June, 1915

Temperature.—The mean temperature of the month was below the normal over the greater part of the Dominion, the only exceptions being some southern sections of British Columbia and a few counties in the eastern portion of Quebec where the normal was slightly exceeded. Negative departures in many places were fairly pronounced, amounting to about six degrees in Manitoba, and ranging between one and four degrees in Alberta, Saskatchewan, Ontario, and the eastern districts of the Maritime Provinces.

Precipitation.—The outstanding feature of the precipitation during June was an excessive rainfall in Alberta, and a marked deficiency in the St. Lawrence Valley and some small districts in Ontario near the west end of Lake Ontario. In other parts of the Dominion, departures from the normal amounts were not great, and were nearly as follows:—British Columbia.—Deficient on the Lower Mainland, and in excess on the Upper Mainland. Saskatchewan.—Slightly in defect, except in west and north. Manitoba.—Deficient in the south, but average or in excess in the north. Ontario.—In excess in the north, especially to the northward of the lakes, and also in the southwestern part of the peninsula, while north of Lake Ontario and the St. Lawrence, it was in defect. In the Maritime Provinces, the normal was well exceeded, except in Prince Edward Island and Western Nova Scotia.

JULY, 1915

Temperature.—The temperature was below the average in all portions of the Dominion, if we except a few isolated localities in Ontario and Quebec, where the normal was just maintained. In many portions of the country the negative departure was pronounced; this was especially the case over the Western Provinces, and in the extreme eastern portions of the Maritime Provinces, the amount varying from three to eight degrees in the former, and from three to seven degrees in the latter districts.

Precipitation.—The rainfall in British Columbia was much above the average amount in Cariboo and inland locally, but less than the usual quantity elsewhere. In Alberta and Saskatchewan it was above the average almost everywhere, the excess in Central and Southern Alberta equalling one-third to one-half more than the general fall. In the vicinity of Battleford it was also one-third more than usual. In Manitoba the fall was average in the western, but only about half the normal in the eastern portion. In Ontario it was well below the average, except in the Peninsula, where it was above, strikingly so at Toronto, which gave a positive departure of 1·60 inches, Port Burwell 5·39 inches, Georgetown 3·95 inches, Aurora 5·11 inches, Port Dover 3·98 inches, Welland 3·84 inches. Quebec was mostly dry, being from 2 to 3 inches below the normal over the larger portion of the Province. In the Maritime Provinces heavy rainfalls were recorded from Chatham to St. John, including the Fredericton Valley, the excess being 2·1 inches at Chatham, 1·6 inches at St. John, and 1·5 inches at Fredericton. However, in the provinces generally the precipitation did not attain to the usual normal quantity and Yarmouth recorded a deficit of 2·60 inches.

Temperature for June and July, 1915

Station	June		July	
	Highest	Lowest	Highest	Lowest
Yukon				
Dawson	88	36		
British Columbia				
Atlin	78	32		
Agassiz	91	42		
Barkerville	72	30	74	32
Kamloops	87	44	96	46
New Westminster	88	45	94	48
Prince Rupert	75	42	79	48
Vancouver	85	46	88	49
Victoria	83	48	87	50
Western Provinces				
Battleford	80	30	85	40
Calgary	78	35	81	38
Edmonton	74	32	78	37
Medicine Hat	84	40	90	43
Minnedosa	84	30	81	37
Moose Jaw	82	27	88	37
Oakbank	84	28	87	37
Portage la Prairie	84	33	85	41
Prince Albert	70	28	78	40
Qu'Appelle	78	26	84	34
Regina	80	26	86	38
Saskatoon	79	29	83	42
Souris	81	32	86	37
Swift Current	80	30	86	36
Winnipeg	86	30	86	38
Ontario				
Agincourt	87	38	87	46
Aurora			84	45
Bancroft	83	38	85	43
Barrie	84	40	87	45
Beatrice	81	39	82	43
Berlin	83	38	85	45
Bloomfield	83	40	84	50
Brantford				
Chapleau	84	32	83	32
Chatham	88	39	92	48
Clinton	85	32	85	44
Collingwood	85	38	81	47
Cottam	85	41	88	47
Georgetown	83	42	84	40
Goderich	83	36		
Gravenhurst	84	40	87	43
Grimsby	90	43	90	52
Guelph	84	36	48	50
Haliburton	90	35		
Huntsville	84	37		
Kenora	79	30		
Kinmount	84	35	86	46
Kingston	81	44	83	52
Lakefield				
London	87	34	89	46
Lucknow	81	30	84	41
Markdale	84	35	85	42
North Gower	90	40		
Oshawa	83	36	86	50
Ottawa	85	47	88	49
Paris	86	39	88	48
Parry Sound	87	39	86	48
Peterboro'	84	39	88	43
Port Arthur	74	32	84	41
Port Burwell	80	38	87	50
Port Dover	79	38	84	48
Port Stanley	80	37	83	46
Queensborough	84	38	87	37
Ronville	83	35	83	42
Southampton	78	36	83	46
Sundridge				
Stonecliffe	90	37	92	42
Stony Creek	88	38	89	49
Toronto	82	43	86	51
Uxbridge	86	39	85	47
Wallaceburg	85	38	85	45
Welland	90	40	85	48
White River	81	24	84	30
Quebec				
Brome	82	38	83	43
Father Point	84	34	85	44
Montreal	84	48	90	55
Quebec	85	43	87	50
Sherbrooke	86	40	86	46
Maritime Provinces				
Charlottetown	70	36	80	48
Chatham	86	35	86	46
Dalhousie	82	34	84	48
Fredericton	82	31	84	44
Halifax	80	32	84	48
Moncton	81	30	81	45
St. John	74	38	80	50
St. Stephen	84	29		
Sussex	86	30	85	45
Sydney	74	32	78	42
Yarmouth	75	35	77	44

Earthquake Records by the Milne Seismograph

TORONTO

R. F. Stupart, Director.

P.T. = Preliminary Tremors. L.W. = Large Waves. A.C. = Air Currents.
Time is Greenwich Civil Mean Time, 0 or 24 h = midnight.

No.	Date 1915		P. T. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Durat.	Remarks
			h m	h m	h m	h m	mm.	h m	
1477	June	1	14 57·6	15 7·5	15 11·3	17 26·2	13·2	2 28·6	Large quake.
1478	"	4	21 23·4	21 38·2		22 19·3	0·05	0 55·9	Movements of these two quakes mixed up with one another.
1479	"	4	22 30·1?	22 44·8 22 52·0	22 56·0	23 21·3	0·2	0 51·2	
1480	"	6	15 48·8?	15 55·5	15 57·2	16 1·6	0·2	0 12·8	
1481	"	6	20 21·5?	20 39·4 20 41·7	20 48·7	21 8·2	0·3	0 46·7	
1482	"	6	21 40·8	21 49·4	21 51·5	3 32·0	0·5	5 51·2	
1483	"	7		12 27·9		12 36·0	0·05	0 8·1	
1484	"	7		22 48·9 22 52·0	22 52·7	23 6·9	0·2	0 18·0	
1485	"	11		7 27·2		7 36·8	0·1	0 9·6	
1486	"	12		6 43·4	6 44·0	6 49·8	0·1	0 6·4	
1487	"	22		3 44·0	3 45·3	4 13·5	0·9	0 29·5	Marked quake.
1488	"	22		13 5·3		13 13·4	0·05	0 8·1	Characteristics of two quakes very similar, Southern California.
1489	"	23	4 6·1	4 17·6	4 17·6	4 34·0	0·4	0 27·9	
1490	"	23	5 6·0	5 12·5	5 12·7	5 32·8	0·4	0 26·8	
1491	"	27	A.C.	16 16·6	16 18·6	A.C.	0·3		
1492	"	29		14 42·1 14 53·6	14 55·4?	A.C.	0·1		

Period = 18·0 seconds. 1 mm. = 0″·59.

VICTORIA, B. C.

F. N. DENISON, SUPERINTENDENT.

No.	Date 1915	P.T. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Durat.	Remarks
		h m	h m	h m	h m	mm.	h m	
1482	June 1	15 0·3 S 15 3·3	15 07·8	15 10·8	16 14·3	6·0	1 14·0	Marked quake.
1483	" 6	At cut off	20 20·4	20 33·6	20 38·4	0·9		Looks like three distinct quakes. Movements mixed.
1484	" 6	21 42·4	21 43·4	21 43·4	21 48·4	1·0	0 6·0	
1485	" 6	21 50·0	21 52·0	21 55·5	?	3·0		
1486	" 6	22 11·4	22 15·4	22 20·8	0 18·4	2·0	2 7·0	
1487	" 11	6 57·7	7 3·7	7 16·7	7 26·7	0·2	0 29·0	
1488	" 22	3 45·0	3 47·5	3 48·0	3 58·0?	0·2	0 13·0	
1489	" 22		13 10·0	13 13·8?		0·05		
1490	" 23	4 7·7	4 11·0	4 12·5	4 18·0	1·0	0 10·3	Southern California
1491	" 23	5 4·0	5 7·5	5 9·0	5 22·0	1·2	0 18·0	
1492	" 27	15 53·0	16 4·5	16 6·0	16 26·0	0·2	0 23·0	
1493	" 29	14 25·0?	14 41·0	14 43·0	15 3·0	0·2	0 38·0	

Period = 18·0 seconds. 1 mm. = 0″·57

J. V.

MAGNETIC OBSERVATIONS

JUNE, 1915

At Agincourt during the month of June, 1915, the magnetic elements were generally disturbed. Beginning on the 16th the largest magnetic storm, since the memorable one of September 25, 1909, was recorded. In all three elements the curves passed both above and below the limits of the photographic paper. Small movements were apparent for some time before the larger changes took place.

In the Declination Curve the main part of the storm began at $20^h\ 50^m$ of the 16th with moderate oscillations continuing until $2^h\ 30^m$ of the 17th, when exceedingly rapid changes took place, the light vibrating back and forth beyond the limits of the paper until about $6^h\ 30^m$, when the amplitude of the swings diminished from 10′ to 20′, the storm, nevertheless, continuing active until the morning of the 18th, with two fairly large departures occurring about noon and at $21^h\ 30^m$.

The Horizontal Curve likewise indicates activity in the magnetic forces for some time prior to the large storm, but after $20^h\ 45^m$ of the 16th, changes were more rapid than in the Declination. Until midnight, however, the movement was of comparatively small amplitudes, and then large changes were recorded, carrying the light below the limit of the paper at $2^h\ 20^m$ and remaining off until $6^h\ 50^m$. From 7^h until 11^h the storm continued very active but the amplitudes of the oscillations were small. At 11^h another period of great changes of Force commenced, decreasing first until the light again passed off the paper for a few minutes and then increasing rapidly until at $12^h\ 40^m$, the curve passed off at the top. The force became more or less normal again at 14^h with, however, small rapid fluctuations until the morning of the 18th.

The Vertical Force Curve exhibits less uneasiness before the storm, the large movements beginning at 23^h of the 16th, with a small decrease of Force, and then by means of a series of swings gradually carried the light beyond the limit of the paper at

$2^h\ 34^m$ of the 17th, a loss of at least 445 γ. Large rapid vibrations then occurred, the light swinging on and off the paper until 6^h when the Force gradually became more or less normal again, with the rapid fluctuations, however, as exhibited by both Declination and Horizontal. At $11^h\ 15^m$ the Force began to increase very rapidly and at $12^h\ 30^m$ passed beyond the paper, an increase of at least 490γ, returning in three minutes and resuming its more or less normal position again about 15^h. At $20^h\ 30^m$ another decrease of force occurred reaching a minimum at $21^h\ 30^m$ with loss of 211γ. The Vertical Force curve gradually became normal again during the morning of the 18th.

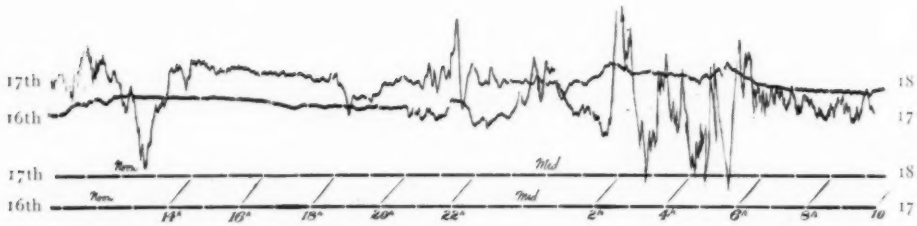
Auroræ of the II. and III. Class were recorded in most parts of Canada on the 16th, 17th and 18th. Several groups of sun-spots were observed on the sun's disc on the 17th, two fairly large groups being central on that day, one north and the other south of the equator. Other groups were in N.E. and S.W. quadrants.

June, 1915		D. West	H	V	I
		° ′			° ′
	Mean of Month	6 28·4	0·16031	0·586444	74 43·0
	Maximum	8 21·7	0·16418	0·591524	
	Date of Maximum	17	17	17	
	Minimum	5 6·2	0·15586	0·580404	
	Date of Minimum	17	17	17	
	Monthly Range	3 15·5	0·00832	0·011120	
Mean Daily Amplitude	From hourly readings	0 11·4	0·00043	0·00029	
	From Means of Extremes	0 23·0	0·00097	0·00072	

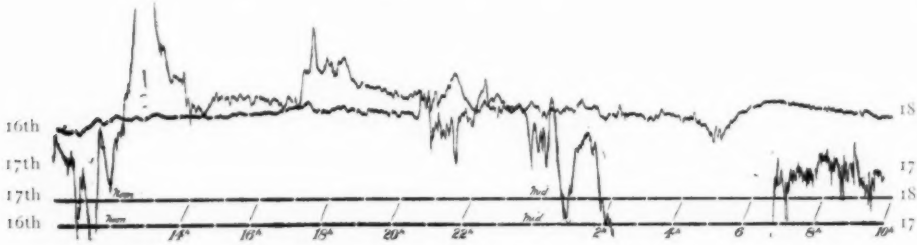
H and V are expressed in C. G. S. Units.

I is the Mean of all Dip observations made during the month with the Earth Inductor, without regard to the time of day at which they were made. Two observations are usually made each week.

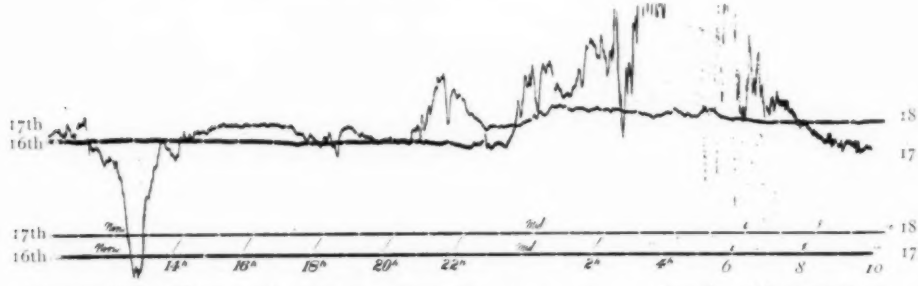
The values of the maximum and minimum for each element are estimated, as the light in each case passed beyond the limit of the photographic paper.



Agincourt Declination June, 1915 — 16th—10·31 to 10·01—17th; 17th—10·07 to 10·03—18th } 75th M. Time. 16th at Noon 18s·2; 17th at Noon 18s·1 } Slow. Base line 5° 23′·5 W. 1mm. = 1′·28 Increase ordinate = Increase W'ly Dec.



Agincourt Bifilar June, 1915 — 16th—10·31 to 10·00—17th; 17th—10·07 to 10·03—18th } 75th M. Time. 16th at Noon 18s·2; 17th at Noon 18s·1 } Slow. Base line 0·161096 1mm. = 0·0000462 Increase of ordinate = Increase of Force.



Agincourt Vertical Force June, 1915 — 16th—10·31 to 10·00—17th; 17th—10·07 to 10·03—18th } 75th M. Time. 16th at Noon 18s·2; 17th at Noon 18s·1 } Slow. Base line 16th 0·589806 17th 0·589820 18th 0·589834 1 mm. = 0·0000556 Increase of ordinate = Decrease of Force.

ASTRONOMICAL NOTES

STELLAR DISTANCES.—In the "Halley Lecture" delivered at Oxford, on May 20, Sir F. W. Dyson, Astronomer Royal, on "Measurement of the Distances of the Stars," in part said :—

For many centuries astronomers had speculated on the distances of the stars. The Greeks measured the distance of the moon ; they knew that the sun and planets were much further away, and placed them correctly in order of distance, guessing that the sun was nearer than Jupiter because it went round the sky in one year while Jupiter took twelve. The stars, from their absolute constancy of relative position, were rightly judged to be still more distant — but how much more they had no means of telling.

The question may be asked, How near must a star be to us for its distance to be measurable ? I think we may say ten million times the sun's distance. This corresponds to the small angle 0·02″ for the parallax (about 160 light years). If a star's parallax amounts to this, there are, I believe, several observatories where it could be detected with reasonable security, though we shall know more certainly by the comparison of the results of different observations when they accumulate.

You will readily imagine that an accurate knowledge of the distances of many stars will be of great service to astronomy. There are ample data to determine the positions, velocities, luminosities, and masses of many stars if only the distances can be found. Thus we know the distance of Sirius, and we are able to say that it is travelling in a certain direction with a velocity of so many miles per second : that it gives out forty-eight times as much light as the sun, but is only two-and-a-half times as massive. The collection and classification of particulars of this kind is certain to give many interesting and perhaps surprising results.—In *Nature*, No. 2379.

STELLAR RADIOMETRY.—Summary of a paper by Keivin Burns, in *Publication Astronomical Society of the Pacific*, No. 159.

The available data show no relation between the spectral energy distribution and the absolute total energy of the star.

There is some evidence of absorption in space.

The fainter companion of a double star appears to have the same ratio of total energy to visibility as the primary, if any difference, the secondary is "redder."

The radiometric evidence points to a lower temperature for stars of class *B* than for stars of class *A*, but this is uncertain since the early type stars do not obey Planck's law. The stars of class *G* to *Mb* seem to have spectral energy curves roughly approximating Planck's law, and the temperature of such a star may be obtained from the percentage of its energy which is transmitted by a suitable screen.

The temperatures found for stars of classes *G* to *Mb* are thought to be correct within a few hundred degrees.

This paper is to quite an extent merely a more detailed statement of points brought out by Dr. Coblentz in his original paper. (Lick Observatory *Bulletin*, No. 8).

ANDROMEDA NEBULA receding from us at about 329 km. per second (about 204 miles). An excellent spectrogram of the Andromeda Nebula was obtained on the nights of November 12th, 13th, 14th, 15th and 16th, 1914, with the small-slit spectrograph at the primary focus of the 60-inch reflector. The total exposure time was thirty-four hours on a Seed 27 plate, with a slit width of 0·025mm. The spectrum is *G* type, the more prominent lines extending over a minute of arc either side of the nucleus (slit E-W). The mean measured velocity given by nine lines is − 329km. reduced to the sun. The plate was measured by Mr. Adams. Other values, mentioned by Slipher in his paper on spectrographic observations of nebulæ in the report of the seventeenth meeting of the American Astronomical Society, are :—

Wolf	− 350km.	per sec.
Wright	− 304	" "
Slipher	− 300	" "

There seems to be no evidence indicating the presence either of bright lines or of a rotational displacement.—FRANCIS G. PEASE, in *Publication Astronomical Society of the Pacific*, No. 159.

THE DISTRIBUTION OF STAR CLUSTERS.—The question of the distribution of nebulæ and star clusters is one which is now becoming of increasing interest. Since the introduction of celestial photography an enormous amount of evidence has accumulated, but in the case of the nebulæ we are even yet without a complete survey of the whole sky. Such a survey requires to be carried out with a reflector of moderately large aperture, and although a great deal has been done in this direction at Lick, Mount Wilson and Helwan Observatories, there still remains a large field awaiting examination.

With regard to star clusters, however, the Franklin-Adams chart plates afford valuable material for a study of the question of their distribution.

The charts give a representation of the whole sky on a uniform system, the plates having received an exposure calculated to reach the 16th to 17th magnitude. Further, the scale on which they are taken, *viz.*, 20 millimetres to the degree, is one well suited to the purpose, for whilst the small "globular" clusters (with diameters not less than 1′) can be identified as such with tolerable certainty, the large open clusters have not lost their characteristic appearance through being presented on too large a scale. The plates have, therefore, been examined and a catalogue formed of the clusters noted on them.

Taking the clusters as a whole it is found that the majority are distributed over a zone within 30° either side of the galactic plane (Milky Way), and that comparatively few, nearly all belonging to Class I., fall outside these limits. Further, there is a marked tendency for the globular clusters to crowd together towards a point about longitude 325°, whilst opposite this point the clusters appear spread out over a somewhat wider range in the latitude and include some of the most extended.—P. J. MELOTTE, in *Journal British Astronomical Association*, No. 7.

J. R. C.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries.

FORECASTING AN AURORA

In recent numbers of the JOURNAL a considerable number of interesting notes on the aurora have appeared and it is hoped that further reports of observations will be received.

On the evening of August 9th, the present writer had a long conversation with his old friend Mr. Andrew Elvins, who, though in his ninety-third year, retains remarkable activity of body and acuteness of mind. For some years he has spent several weeks of the summer under canvas. Mr. Elvins explained how the appearance of the sky at 1.30 p.m., June 12 last, led him to predict an aurora which was seen during the following night. He says :—

"There were a great many faint fleecy clouds scattered over the sky. I had the best view from our camp near the lake shore at the eastern limits of Toronto. The clouds would be almost invisible sometimes for a short period ; then they would become bright at one point and then brighten up parallel to the horizon. They showed a purple color at times, and on the whole the sky looked much like an aurora borealis, lacking brilliancy. Mr. D. H. Robinson, who lives near us, was with me at the time and I called his attention to the phenomena which I have tried to describe.

That night, at about 10.50, Mr. Robinson saw a bright aurora, and my friend Mr. W. H. Blizzard, near Upper Canada College at that time, tells me he saw a bright aurora. I telephoned the Meteorological Observatory and found that on that night

an aurora of the second class had been observed. Mr. Hunter's letter shows that it was bright at Barrie."

SIMULTANEOUS MAGNETIC STORM AND AURORA

Director Stupart has kindly sent the present writer copies of the magnetic records obtained photographically at Agincourt on the 16th and 17th of June. (As reproduced on page 364). A decided magnetic disturbance began at about 8.20 p.m. on the 16th, became very violent from 2.15 to 6.30 a.m. next morning, and did not subside until about 6 a.m. of the 18th. In our last issue (page 328-29) reference was made to the brilliant auroræ seen at that time.

AUDIBILITY OF THE AURORA

Mr. Elvins also sends me the following note:—"In the May-June number of the JOURNAL is given (page 268) an extract from a letter on the Aurora sent by Mr. Lethaby, of Victoria, B.C., for which some old observers thank you. The writer of the extract *heard sounds* and gave reasons why he thought the aurora must have been *near the earth* as it seemed to be between him and some trees on the other side of a river. Every fact referring to sounds is interesting, as I see some are sceptical even yet, though, I think, the fact that they have been heard and described by Mr. Hollingsworth, Mr. Robert Dewar and Mr. Z. M. Collins, in our own province, would be regarded as conclusive on this point.

The fact that the aurora was seen between the observer and trees on the other side of a river is of especial interest to me. I have much wished to see a repetition of an aurora which I witnessed about twenty years ago but I have not succeeded. I was at my home, 11 St. Vincent Street, Toronto. The Yonge Street Fire Hall was a little east of where I stood and I could not see beyond it. A number of auroral rays were visible between myself and the tower but they vanished there. They seemed to arise from the earth and move upward to the zenith. I heard a

lecture at the Canadian Institute which described something much like it, and now Mr. Lethaby's letter gives a similar observation."

DEATH OF W. H. S. MONCK

On June 24, 1915, occurred the death of William Henry Stanley Monck, M.A., whose name has been well known in the astronomical world for many years. He was born in 1839, the son of Rev. Thomas S. Monck, Rector of Innistogue, Ireland. At Trinity College, Dublin, he distinguished himself, obtaining on graduation the first mathematical scholarship. In 1861 he obtained a fellowship; was prizeman in 1867-68; and from 1878 to 1882 he was professor of moral philosophy. In 1875 he was called to the bar but he never enjoyed any extensive practice. For some years he was Chief Registrar of the Bankruptcy Division of the High Court of Ireland. Many years ago he was elected an honorary member of our Society and contributed a number of papers to the JOURNAL and to its predecessor, the annual publication of the Society. These referred chiefly to meteorites, ancient eclipses, and the proper motion and distribution of the stars, though on several other subjects his notes, written in a fine hand usually on small sheets of paper, were always read with interest. Mr. Monck was a nephew of Sir Charles Stanley Monck, Governor-General of Canada from 1861 to 1868, during the period of the inauguration of the Federal Constitution of the Dominion.

DEATH OF G. F. CHAMBERS

I learn also of the death of George F. Chambers, on May 24, at the age of seventy-four years. Mr. Chambers was the author of several popular works on astronomy, his most noted one being his "Handbook" which ran into four editions, the last one being in three beautifully printed volumes.

C. A. C.